CIRCULATION COPY
SUBJECT TO RECALL
IN TWO WEEKS

PREPRINT UCRL-83521

Lawrence Livermore Laboratory

OCTOPORT - USE OF AN SEL 32/75 AND REGIONAL PROCESSING UNITS AS A MINICOMPUTER CONCENTRATOR

David N. Hunt

October 29, 1979

This paper was prepared for submission to SYSTEMS User's Group General Meeting in New Orleans, La., January 29-31, 1980.

This is a preprint of a paper intended for publication in a journal or proceedings. Since changes may be made before publication, this preprint is made available with the understanding that it will not be cited or reproduced without the permission of the author.

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

OCTOPORT - USE OF AN SEL 32/75 AND REGIONAL PROCESSING UNITS AS A MINICOMPUTER CONCENTRATOR*

David N. Hunt

University of California
Lawrence Livermore Laboratory
Livermore, CA 94550

October 29, 1979

ABSTRACT

Lawrence Livermore Laboratory (LLL) is currently building a high-speed Data Communications System that will allow remote, user-operated minicomputer systems to share the resources of Octopus, the large, on-site computer network. The system will accommodate minicomputers from different manufacturers, operating at different speeds and under different protocols. An SEL 32/75 serves as a concentrator for four Regional Processing Units (RPU), each of which multiplexes 32 communication lines. Octoport provides 128 high-speed (9600 - 250 K Baud) serial lines to remote (up to two miles) users. This paper will discuss the integration of the RPU into the Octoport system.

* Work performed under the U.S. Department of Energy by the Lawrence Livermore Laboratory under contract number W-7405-ENG-48.

Introduction

Lawrence Livermore Laboratory is a research facility with a large number of diverse groups, each investigating their particular speciality. Minicomputers are being used to aid an increasing number of these groups in the performance of their work, assisting in such tasks as data acquisition, pre and/or post processing of files and text editing. This growing group of user-operated processors contain computers from several manufacturers which are geographically spread over the Laboratory's one square mile site.

With the development of this type of user, it became necessary to provide remote minicomputer systems with a means of sharing the resources of Octopus, the Laboratory's large central computer network. Access paths were needed to the six large worker machines, the file transport and mass storage system, and also the hard copy system, CHORS, which provides both high-speed paper and film output.

Proposed Solution

Octoport, a midicomputer-driven, remote computer system concentrator was proposed to handle the needs of the remote minicomputer users. This system was to provide 128 high-speed serial lines offering multiple baud rates in the range of 9600 baud to 1 M baud. Both asynchronous and synchronous communication under several different protocols were to be provided. An additional feature of the system was to provide a path for user minicomputers to communicate with each other. Service by this concentrator was to be provided for computers of all makes and models.

The proposed connection to the Octopus Network was through a Network Systems Corporation (NSC) adapter to the Hyperchannel,[1] a 50 Mb coaxial bus used at LLL to interconnect several worker computers and the major subsystems of Octopus (see Figure 1). The link to this bus must be capable of sustaining a 40 Mb/sec rate to support CDC 819 disks without slipping revolutions. A prime requirement of the system was that it must support the simultaneous use in either direction of all user lines, the network connection and the CPU without degradation of throughput of any of these parts.

Hardware Implementation

Through a competitive bidding process, Systems Engineering Laboratory (SEL) won the contract for Octoport (see Figure 2). Their proposal included an SEL 32/75 CPU with a real time clock (RTOM), an Asynchronous Data Set Interface (ADSI) for a display terminal and software download path, and a TLC controller for the system console and cardreader. A High Speed Data interface (HSD) provided the connection to Octobus, the on-site NSC Hyperchannel, through an NSC A-470 adapter. One of the major pieces of Octoport, the communications multiplexor, was unavailable commercially. SEL's proposal

---

[1]Hyperchannel is a trademark of Network Systems Corporation.

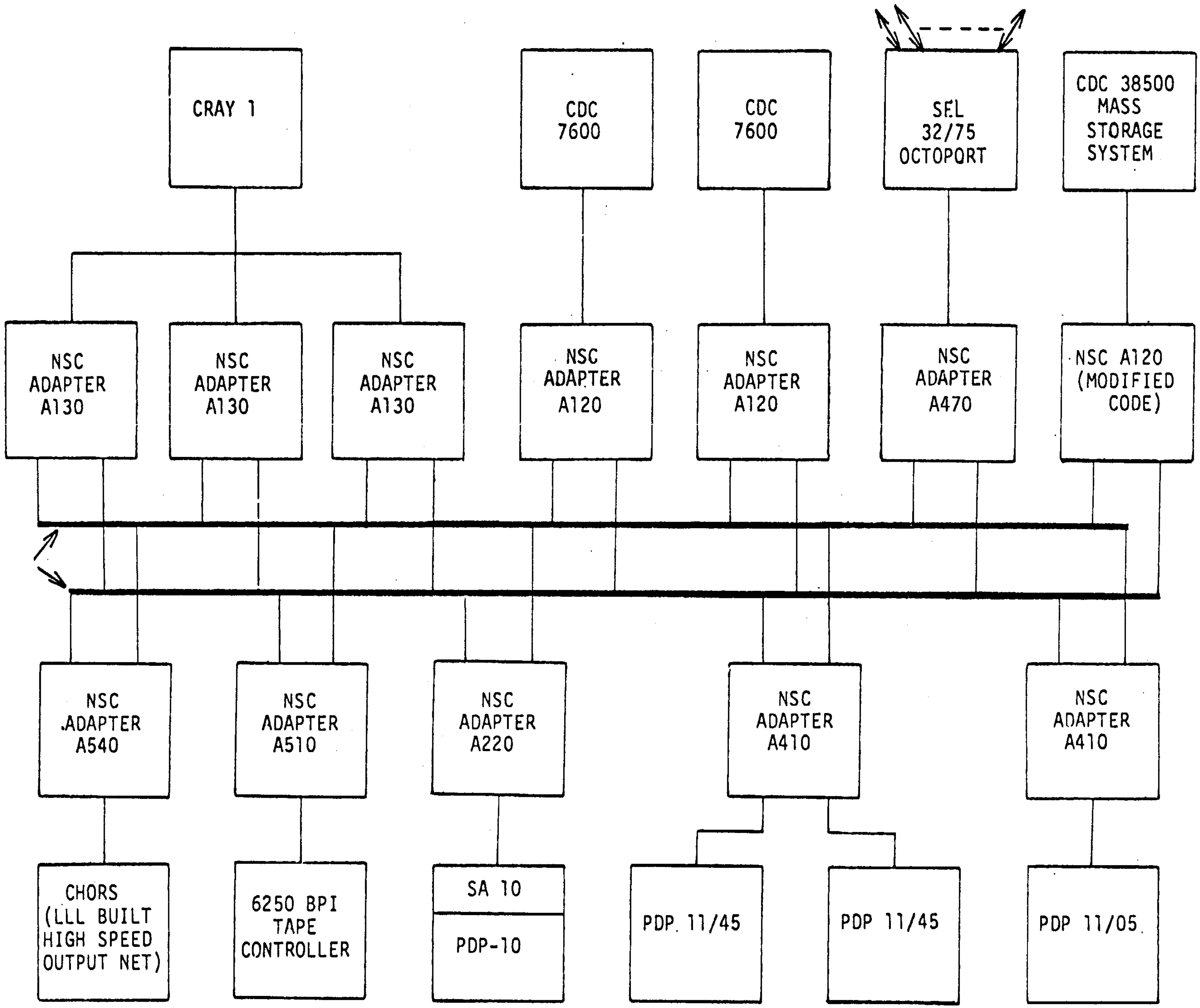
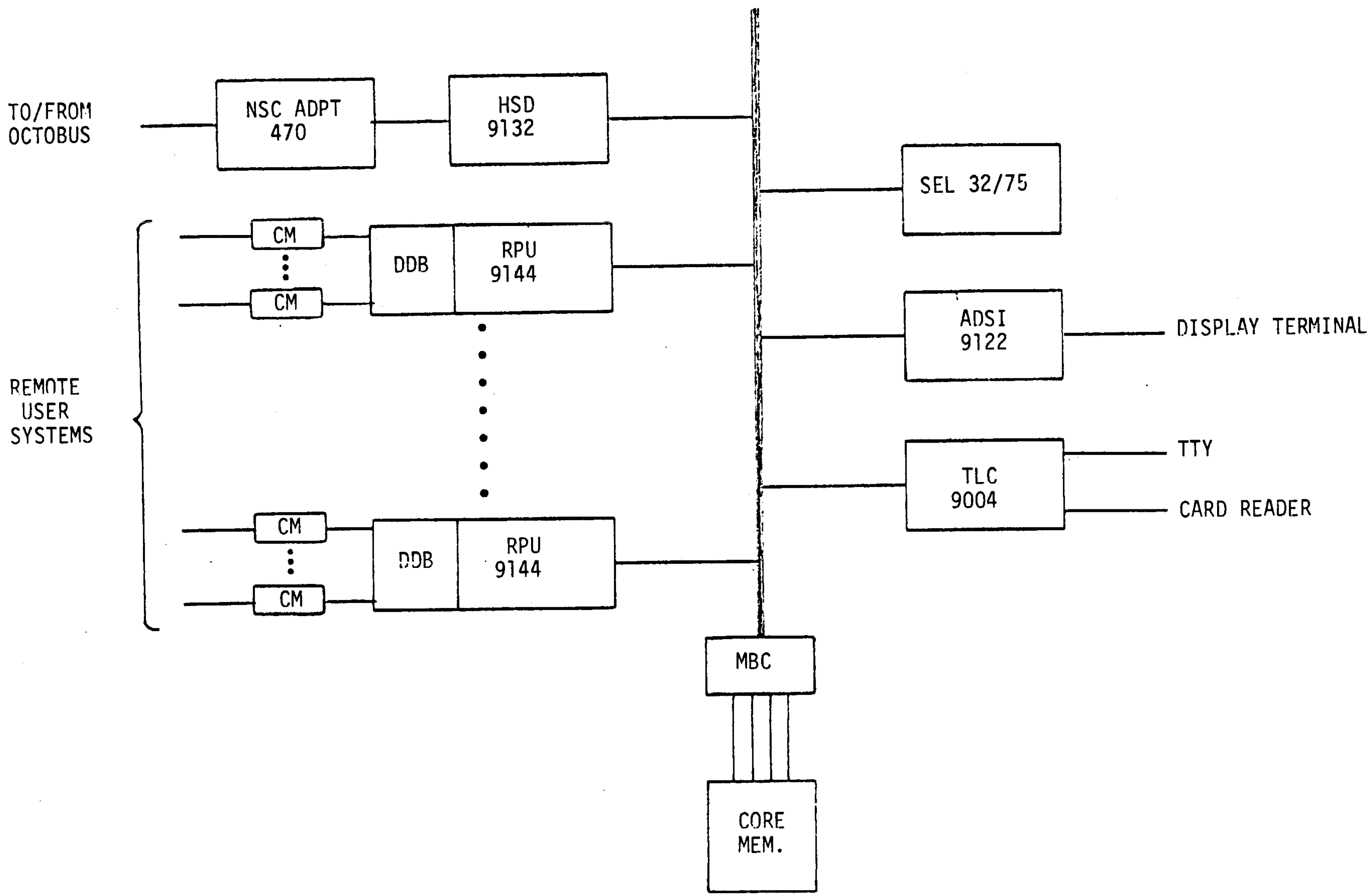


FIGURE 1. OCTOBUS, THE NSC HYPERBUS AT LLL

FIGURE 2. OCTOPORT



included the Regional Processing Unit (RPU), a high speed, user programmable, general purpose I/O interface to provide the interface to the communications multiplexor which would have to be obtained elsewhere.

The Multiplexor was designed by and is being built at LLL. It includes four RPU's, each driving a bus which handles 31 line driver modules. Each RPU is capable of handling a throughput of 10 M baud. The different protocols and line speeds are handled by microprogrammable, LLL designed communication modules, each of which handles one remote user.

Communication Multiplexor

The RPU (see Figure 3), the heart of the communications multiplexor, has a microprogrammable 16/32 bit architecture with 2048 words of program storage on board. Its features include a 16-bit arithmetic logic unit, sixty-four 16-bit registers, a 16-bit input/output data interface, an order structure and a test structure. One end of the RPU plugs into the SEL bus of the 32/75; the other end attaches to the device interface board (DDB).

The DDB (see Figure 4) adapts the general purpose I/O interface of the RPU to drive the bus (CMBUS) interconnecting the communication modules (CM). Data paths between the RPU and CM bus are provided by the DDB along with registers to latch the current data on these paths. Control circuitry on the DDB, which drives the CMBUS through its command cycles, is controlled by the order structure of the RPU. This structure includes both order pulses, which are the actual commands, and order levels which are used as qualifiers on the commands. A 1024 word by sixteen bit scratch pad RAM is also provided on the DDB for the storage of variables used by the RPU firmware for each CM.

The interface between the RPU and DDB consists of two sixteen-bit output ports, one used for data and one to address the RAM, and one sixteen-bit input port, used for incoming data. Six order pulses are used as commands to the DDB and seven order levels are used as qualifiers to these commands. The DDB reports status about the ordered command cycles back to the RPU with ten test signals. Four types of command cycles can be initiated in the DDB by order pulses from the RPU. These include selecting a CM on the bus, outputting to a selected CM, inputting from a selected CM, and writing or reading scratch pad RAM.

The RPU/DDB combination drives the CMBUS which links this pair to thirty-one CM's. This bidirectional bus (see Figure 5) consists of two unidirectional ten-bit busses, each having eight data lines, one status line, and one parity bit across the other nine bits. There are three Go pulses, which are commands to the CM on the bus, and three Acknowledge signals from the CM's to the RPU. The last line of the bus is a Reset line. There are three types of bus cycles on the CMBUS; select a CM, output to a selected CM and input from a selected CM. With the Reset line, the RPU/DDB can reset a selected CM.

The communication modules (see Figure 6) are LLL-designed line handlers which are driven by a Signetics 8X300 microcontroller and 1024 words of LLL-written firmware. The CMBUS end of a CM consists of a selection circuit,

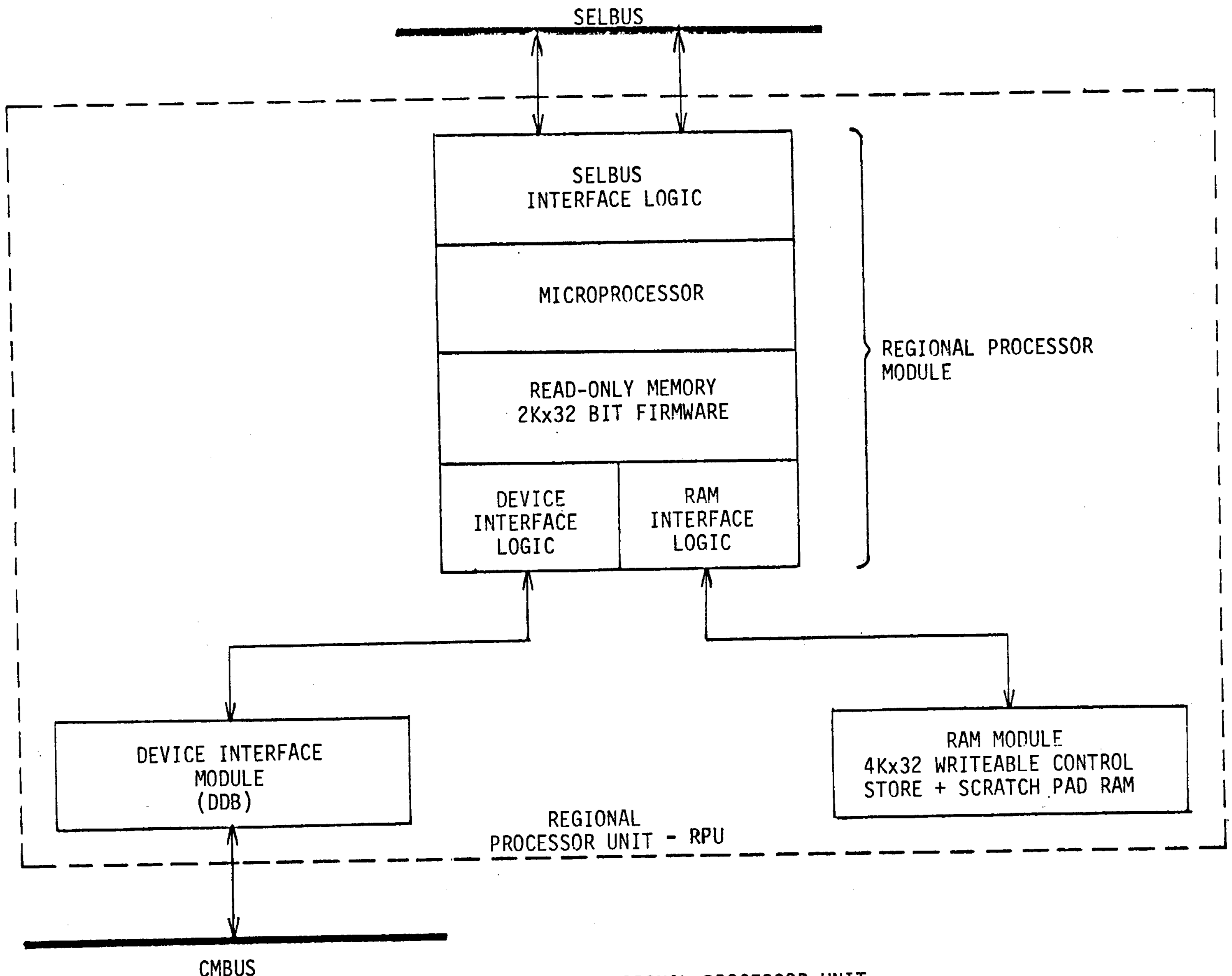


FIGURE 3. REGIONAL PROCESSOR UNIT
BLOCK DIAGRAM

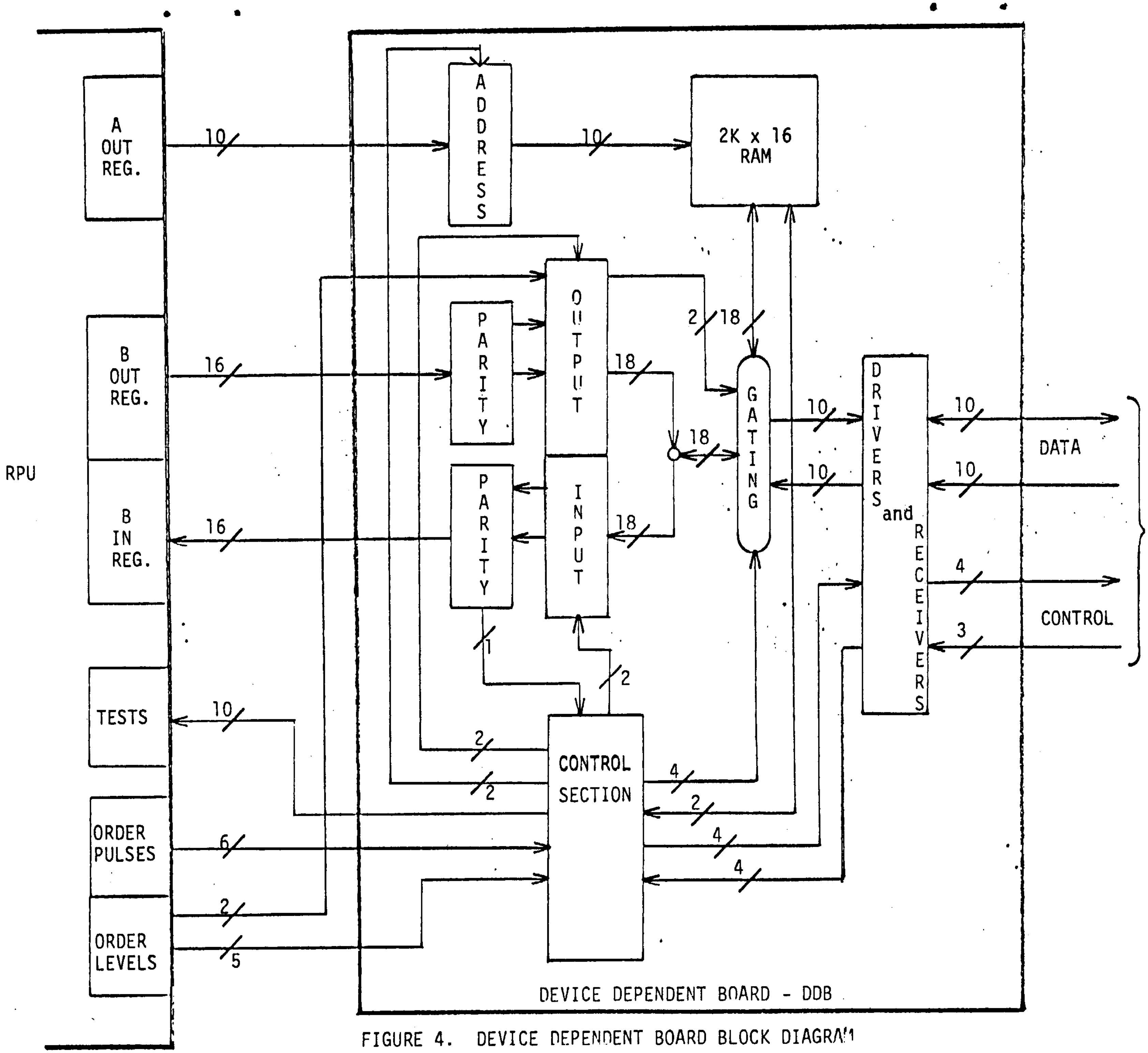


FIGURE 4. DEVICE DEPENDENT BOARD BLOCK DIAGRAM

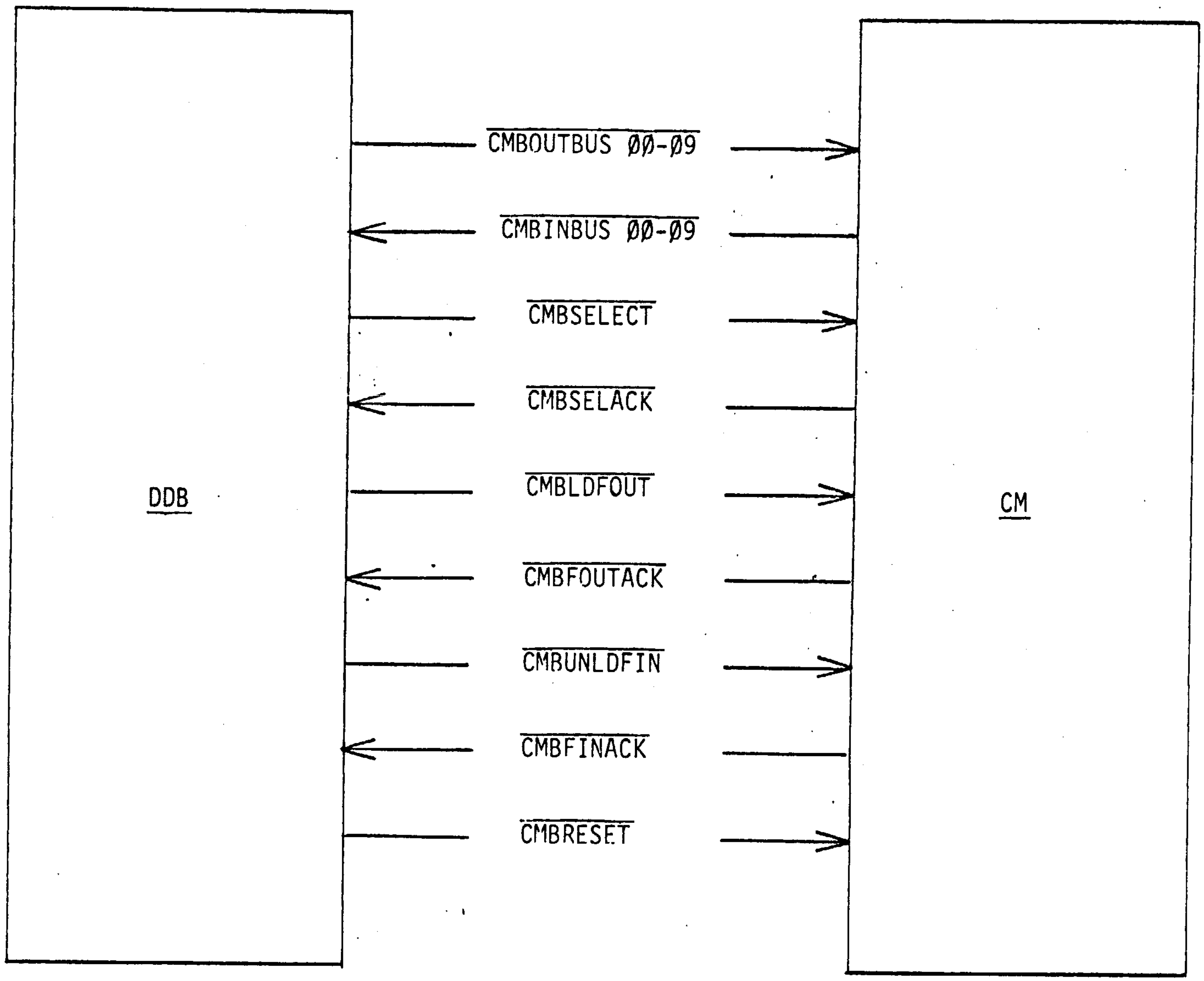


FIGURE 5. CMBUS DESCRIPTION

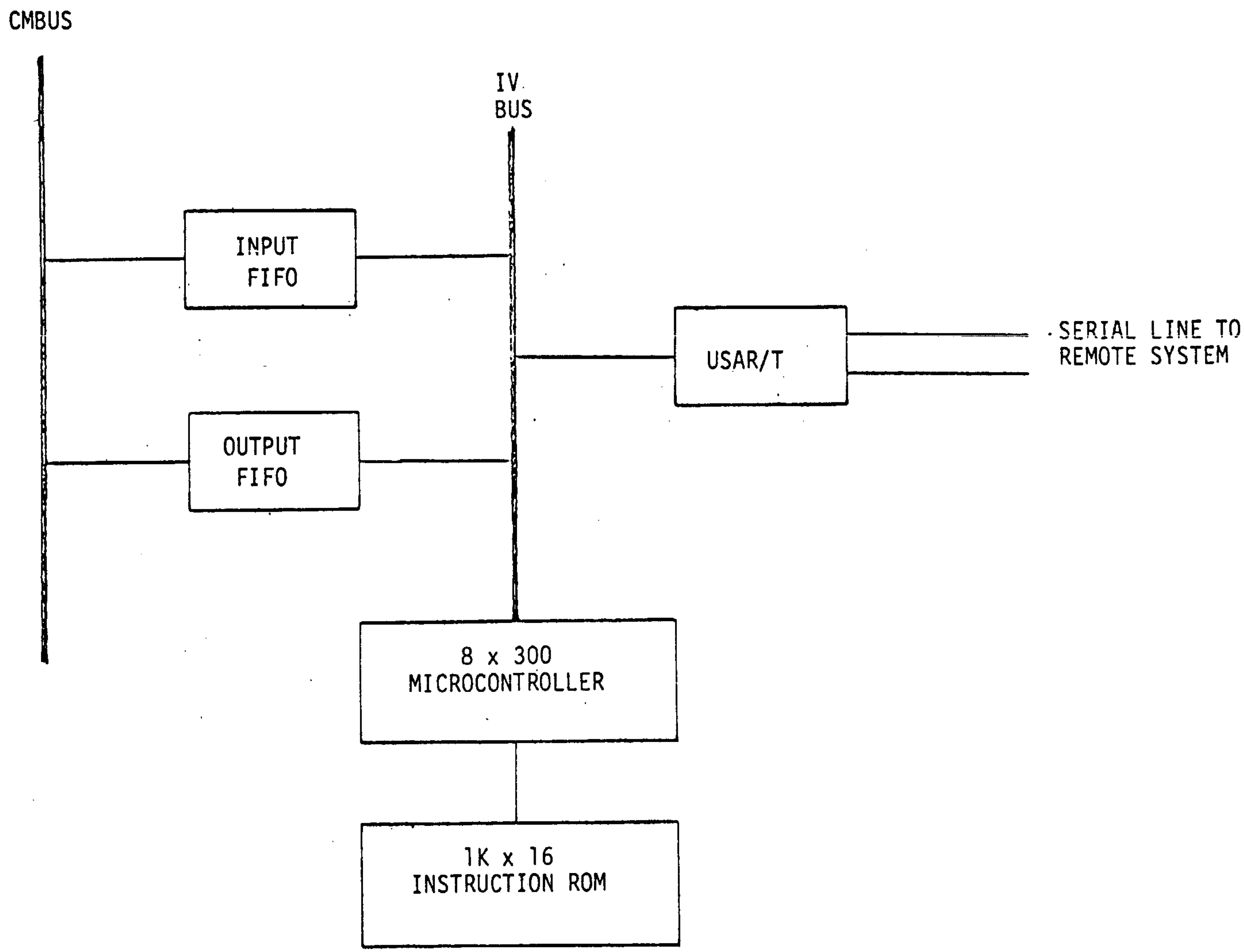


FIGURE 6. COMMUNICATION MODULE BLOCK DIAGRAM

and two 64 x 10-bit FIFO's. The user end of the module is a USAR/T with the line driving circuitry needed to handle the user's selected protocol. There are two versions of the communication module: CMA, an asynchronous version handling line speeds of 110 baud to 19,200 baud using asynchronous SCULL, an LLL-designed serial line protocol, and CMS, a synchronous version, handling line speeds of 50 K baud to 250 K baud using either synchronous SCULL or X.25 as a line protocol. Communication modules capable of 1 M baud will require an architecture different from the current CM's as the current microcontroller has reached its limit at 250 K baud. Design of these 1 M baud CM's has been postponed to a future date.

System Operation

The SEL 32/75 CPU controls transfers to and from user minicomputers and to and from Octopus. Buffers for input messages and those containing output messages are allocated by the CPU in main memory for each RPU. User's files are staged through CDC 819 disks over the HSD-Octobus link. File space on these disks is managed by the CPU.

The function of the RPU is to multiplex the thirty-one user lines into the SEL main memory. Job requests and buffer space are provided by the CPU. The RPU polls the thirty-one CM's in its care in the following manner:

- Select the next communication module.
- Check to see if data transfers need to be made to this CM during this pass. This sampling rate is determined by the baud rate of the serial line to the user.
- If there is data available for input from the selected CM's Input FIFO, then input this data until...
    - the input FIFO becomes empty having no more data to input.
- If there is data in the output buffer to be sent to the selected CM, output that data until...
    - the time allotted to this CM is used up. This is not an actual time but rather a maximum number of words to be sent.
    - the Output FIFO on the selected CM becomes full leaving no more space to receive further data.
    - the current output message ends.
- Proceed to the next CM.

Assisting the RPU perform its functions is the DDB, which adapts the general purpose I/O interface of the RPU into a CMBUS controller. The RPU first sets up the needed data and command qualifiers and then pokes the DDB to initiate a command cycle. During a command cycle the DDB satisfies the request by gating the proper data from source to destination, giving a Go command and then waiting for acknowledgment of the command. On the receipt of an Acknowledge or after a timeout, the DDB reports the completion of the job and gives status information to the RPU concerning the outcome of the job. After receiving the done flag from the DDB, the RPU acknowledges Done, checks the status flags, and terminates the command cycle.

Progress

The equipment purchased from SEL has been received and has passed the thirty-day acceptance test. The device interface board (DDB) for the RPU has been designed, built, and is currently working. The asynchronous version of the communication module (CMA) has been designed and prototyped and is now in PC fabrication. Production for the CMA's should start in January 1980. The synchronous version (CMS) is designed and is being prototyped with production to start in June 1980. The software to run the system is currently under development and will provide simulated terminal traffic in January 1980, with file transport to follow in July 1980. System integration of hardware, software, and the remote users' equipment is currently in progress using the CMA prototype, the current software package, and a volunteer first-time user system.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights.

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.